

Figure 1

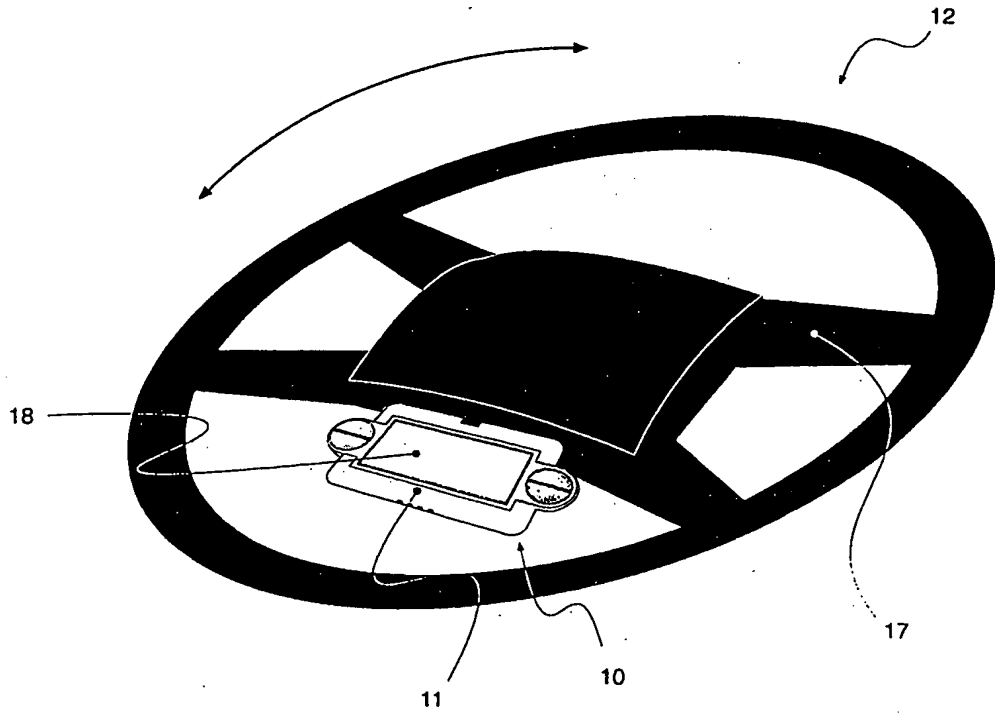


Figure 2

LIKELIHOOD OF FALLING ASLEEP

1= unlikely, 2= possibly, 3= likely, 4= very likely, 5= certain

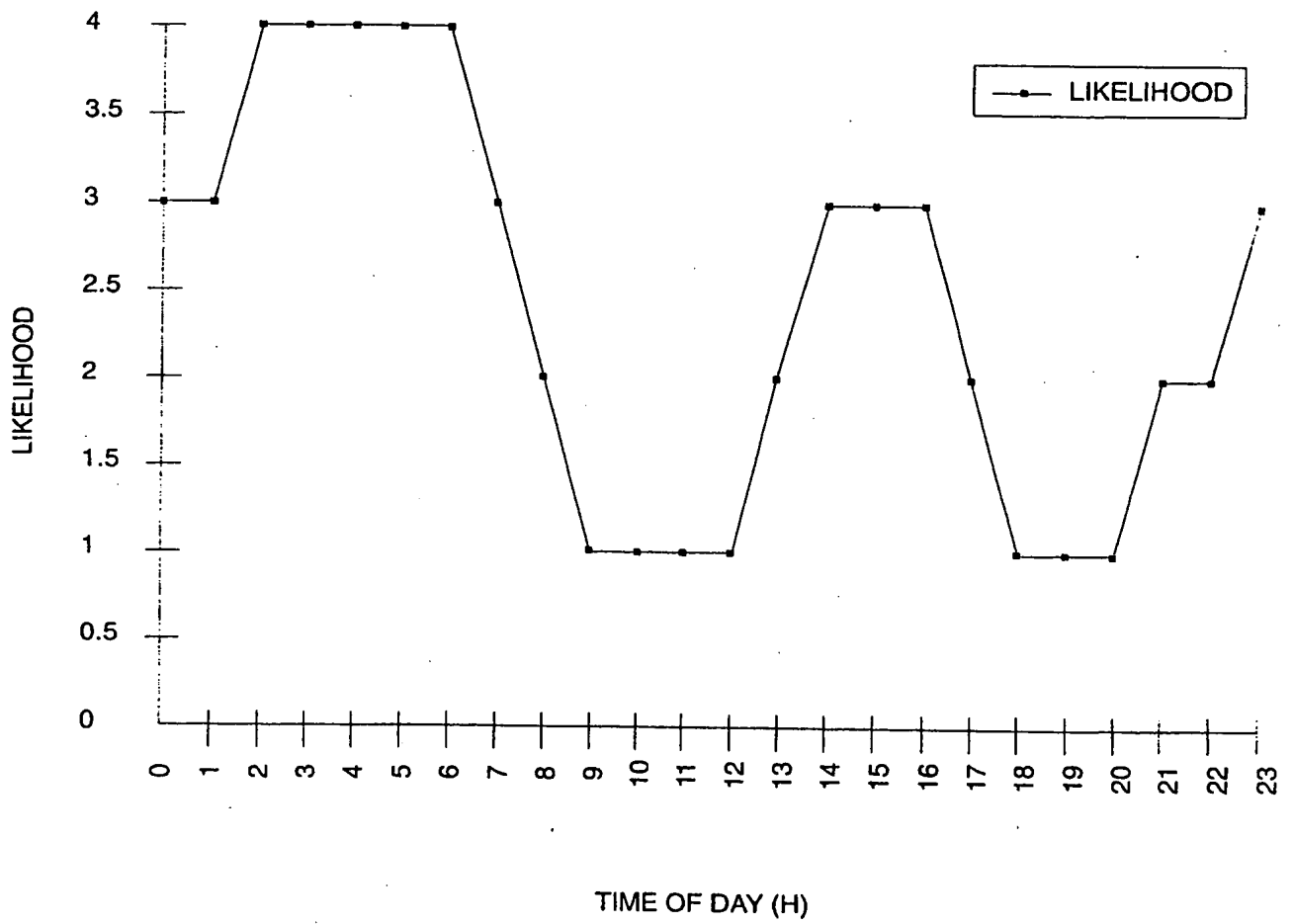
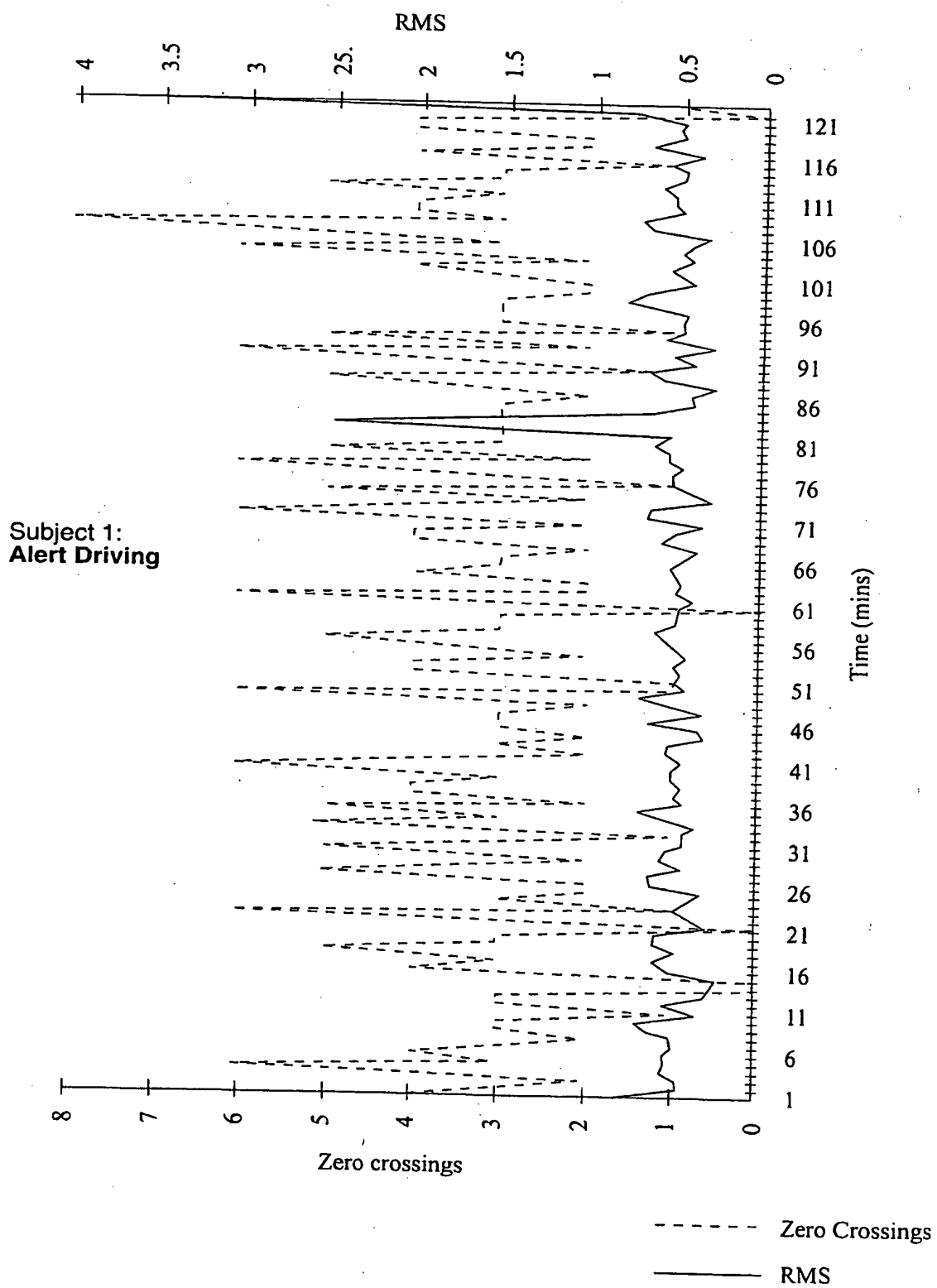


Figure 3

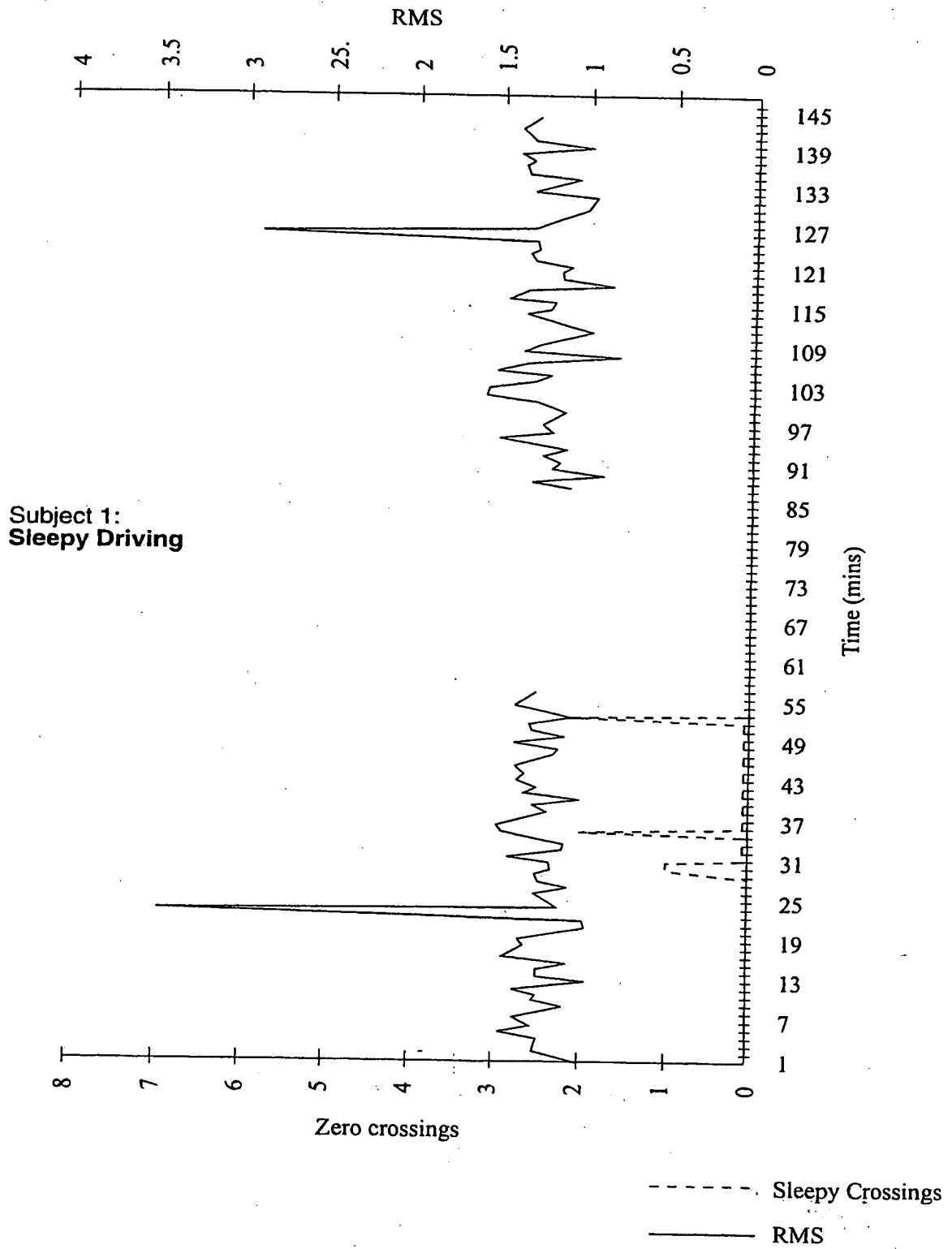
4/30

Figure 4



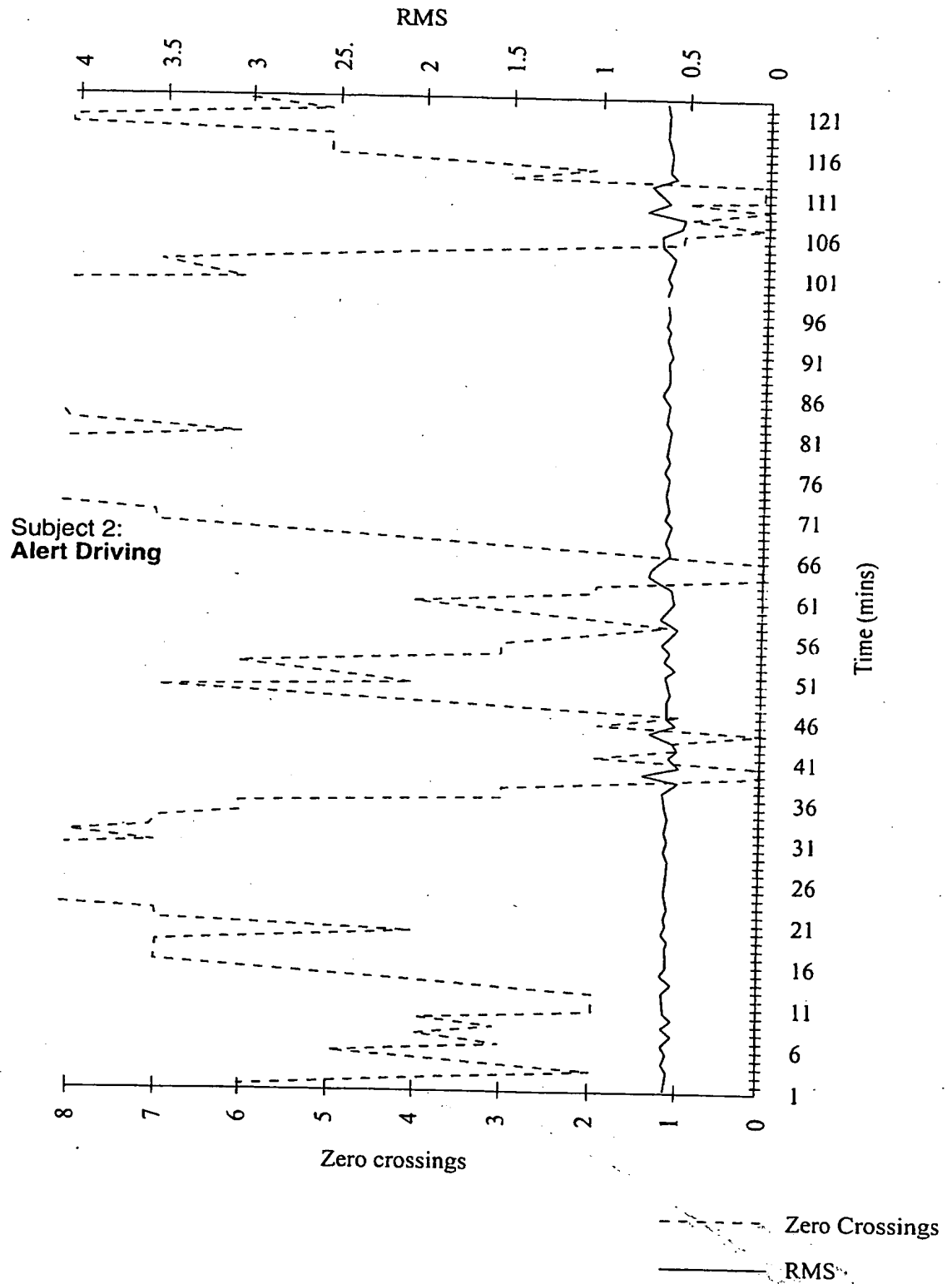
5/30

Figure 5



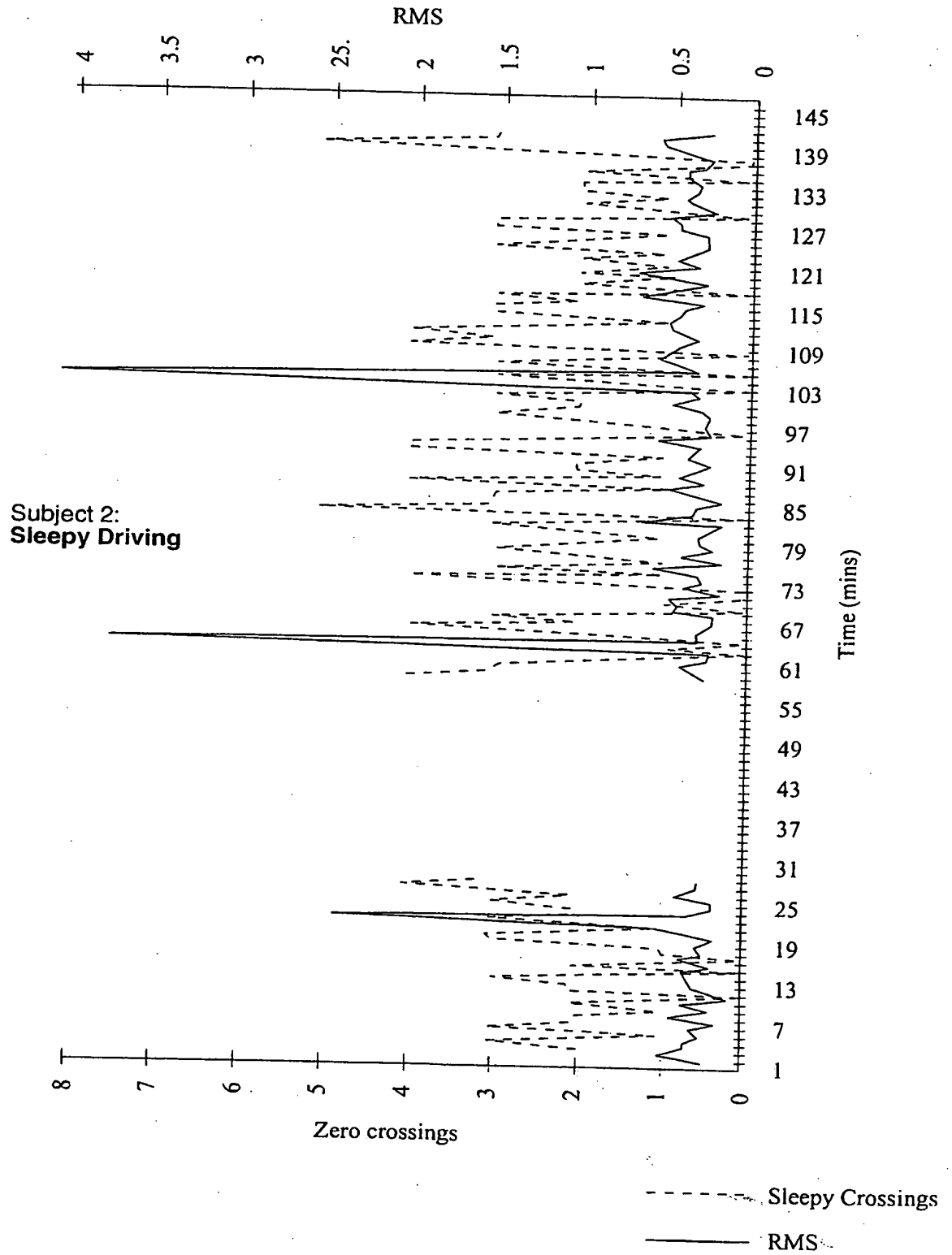
6/30

Figure 6



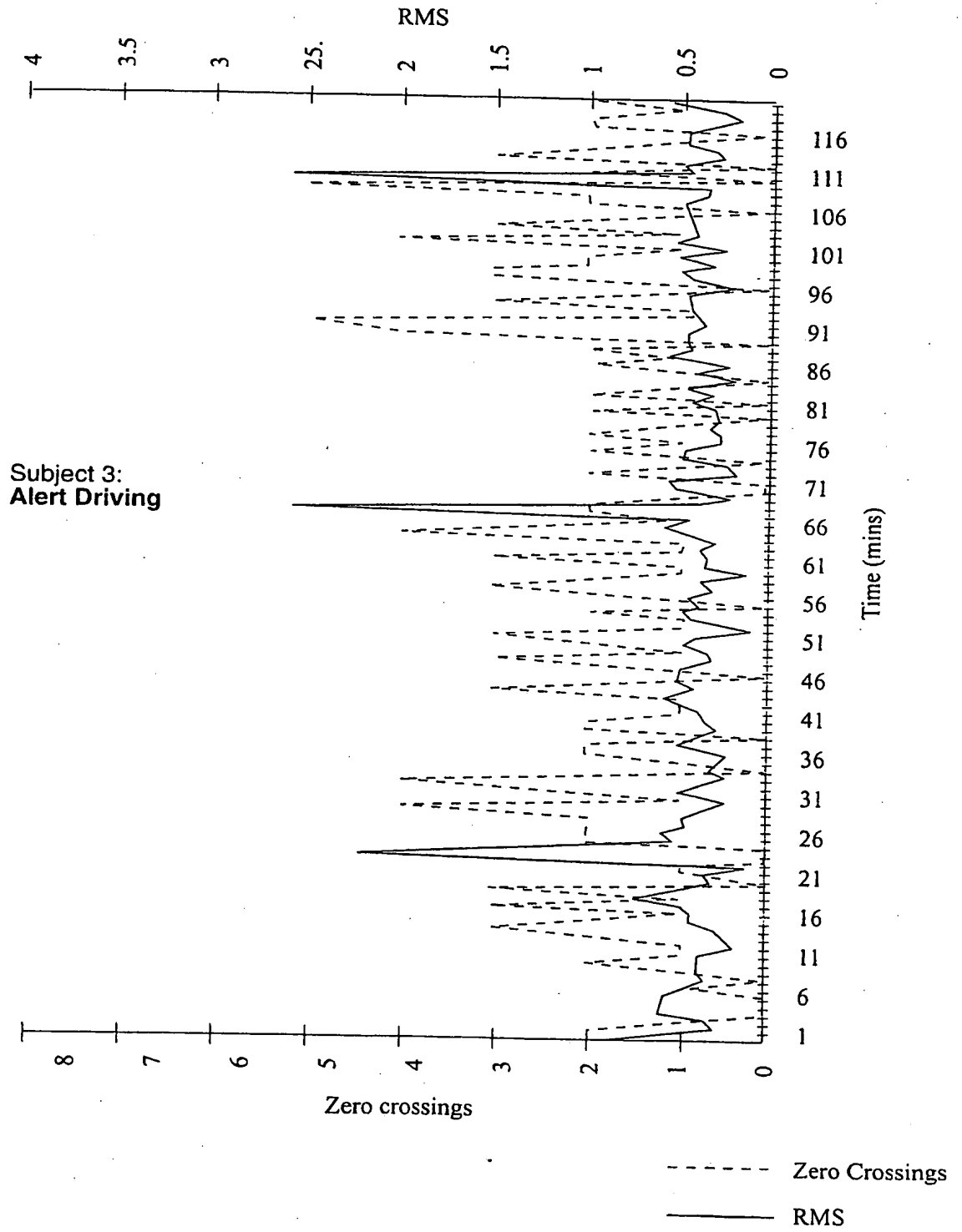
7/30

Figure 7



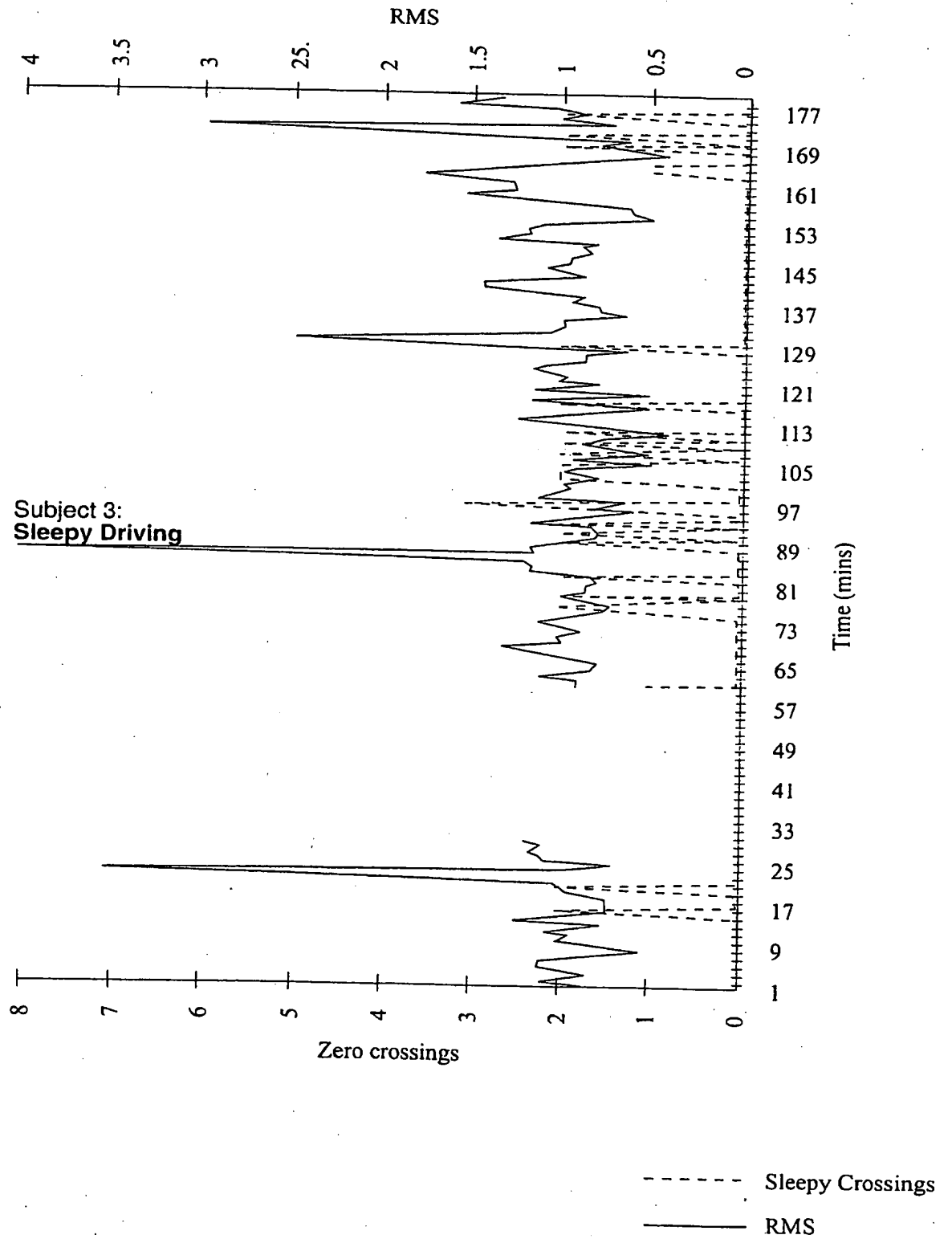
8/30

Figure 8



9/30

Figure 9



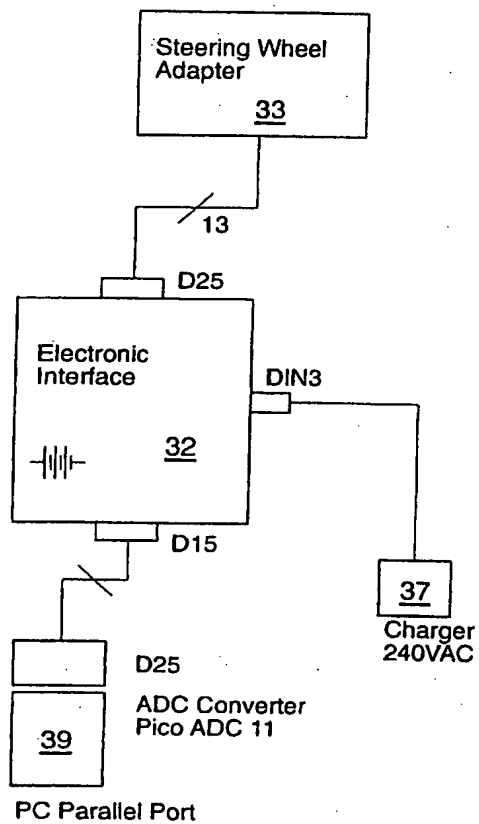


Figure 10

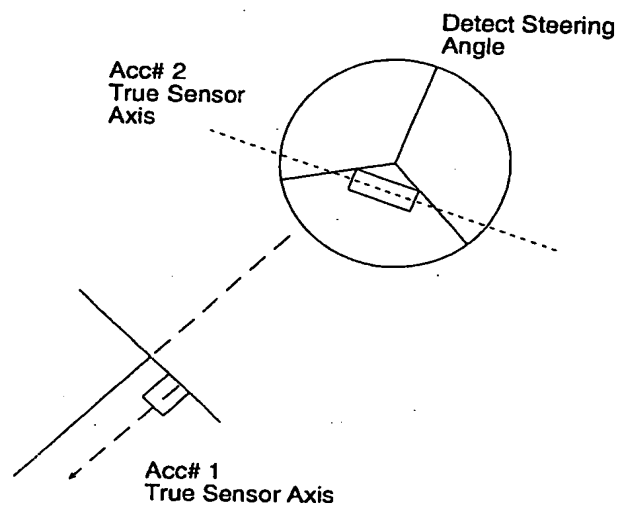


Figure 11

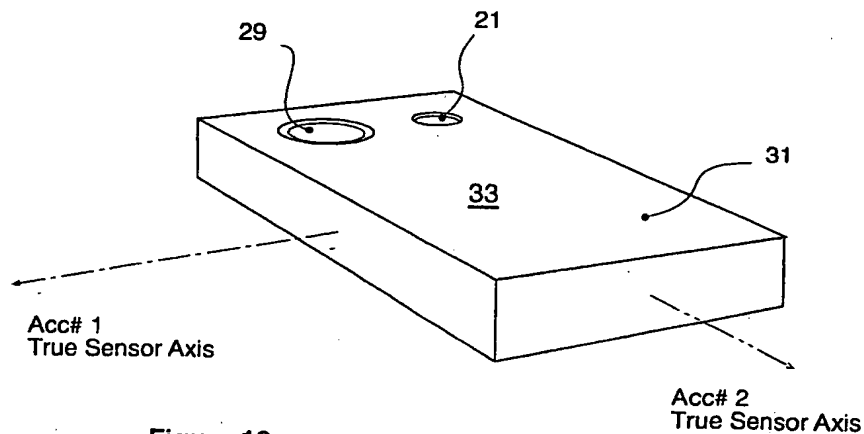
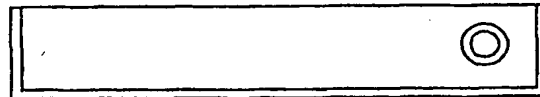
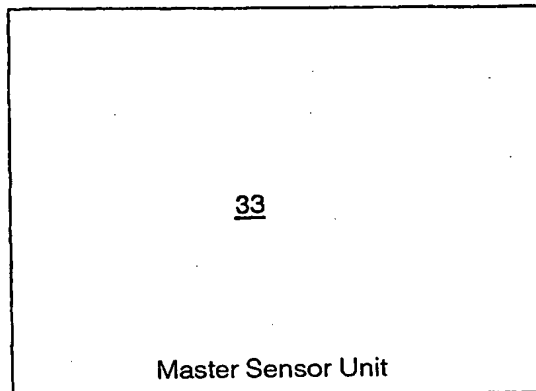


Figure 12

11/30



Rear panel
Figure 13D



Top View
Figure 13C

Side view



29

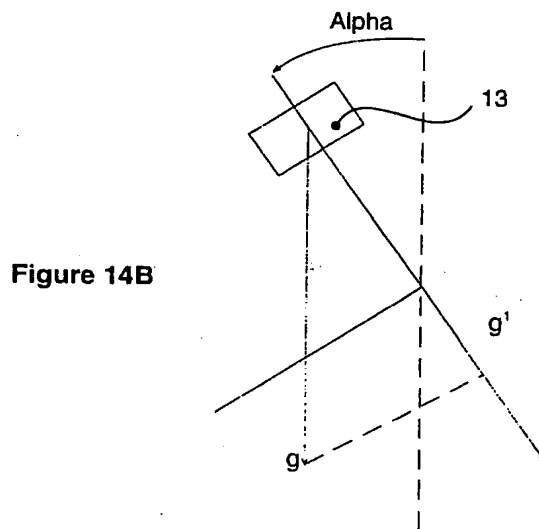
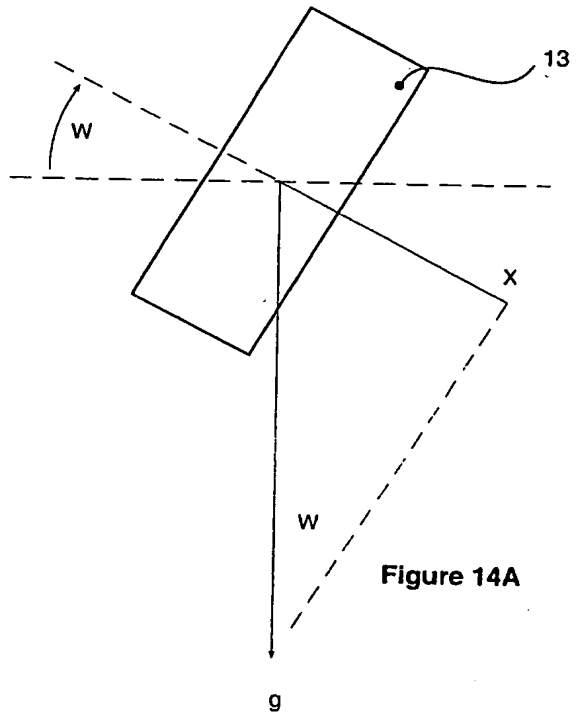
Running LED

Warning LED's

18

Figure 13B

Figure 13A



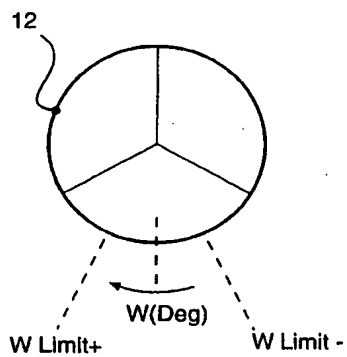
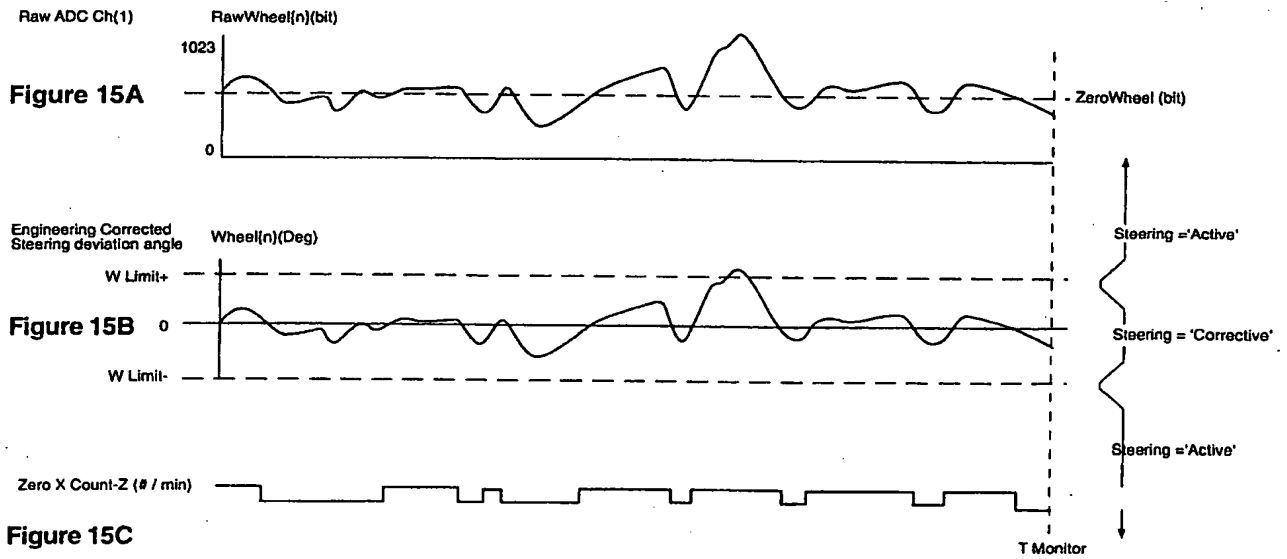
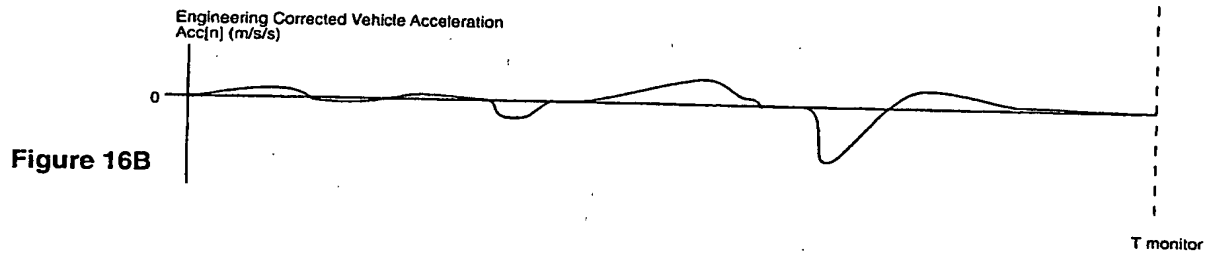
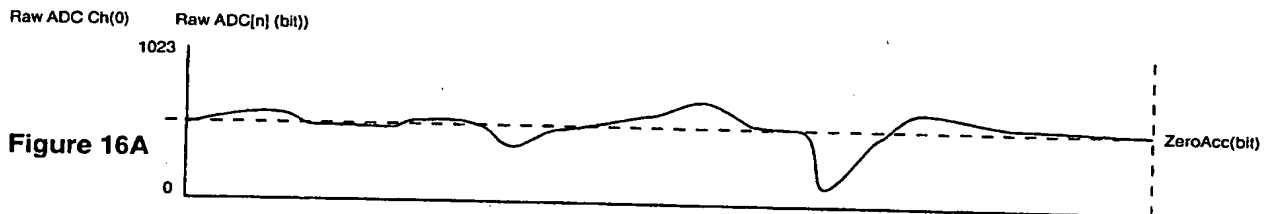


Figure 15D



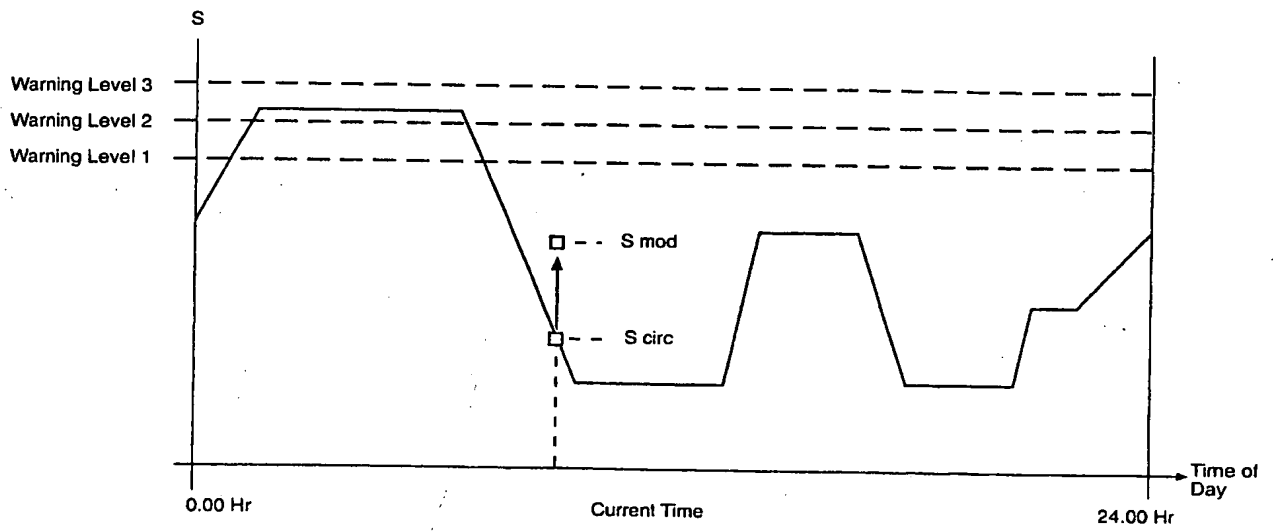


Figure 17

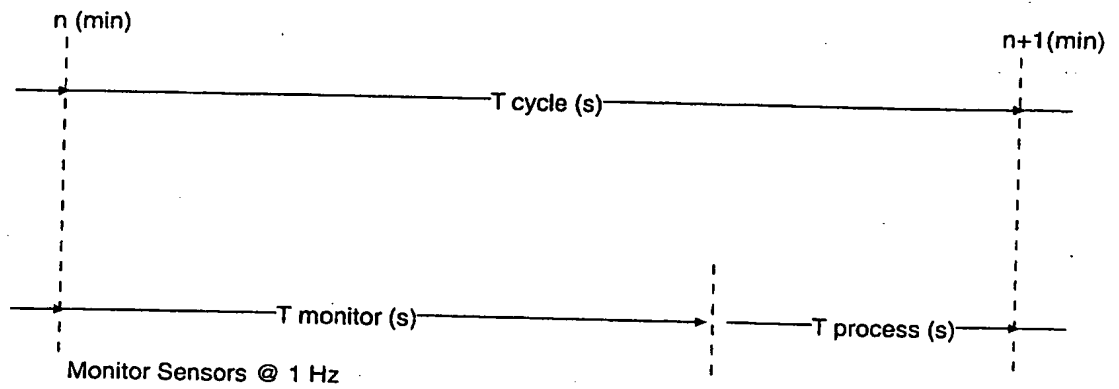
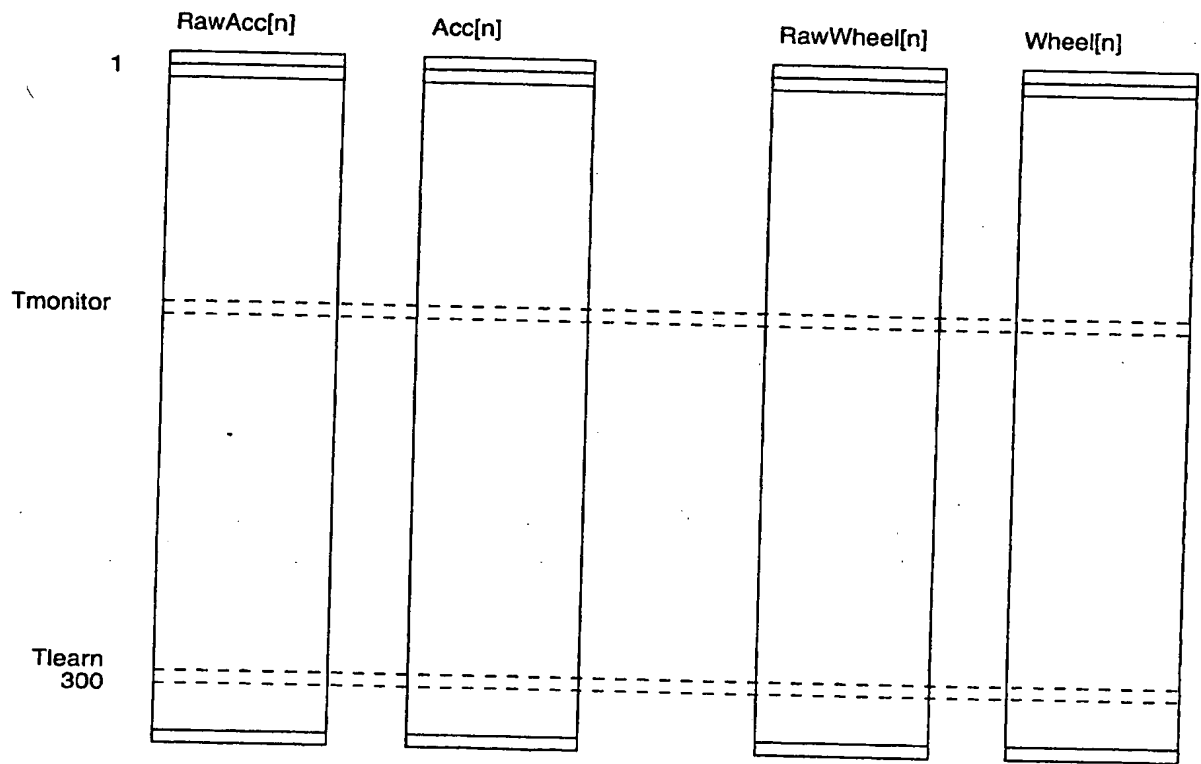


Figure 18

Figure 19



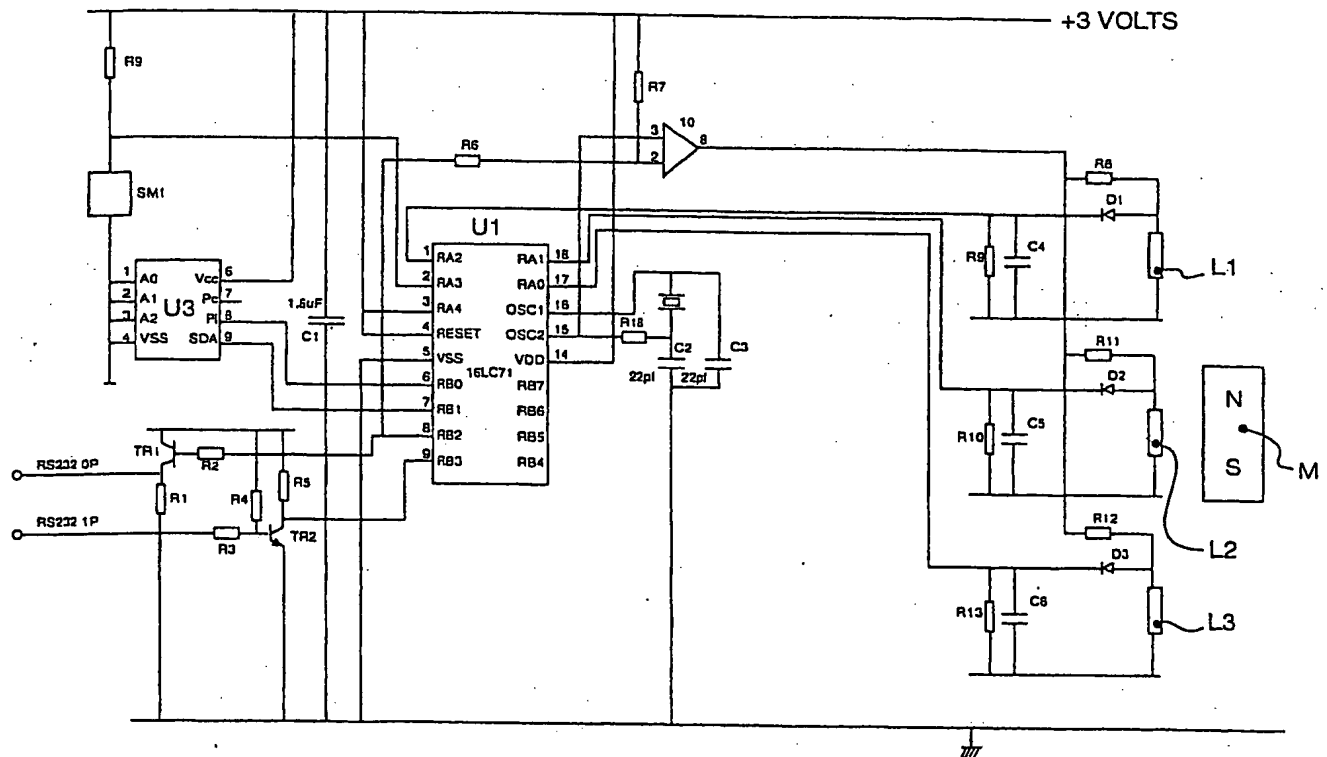


Figure 20

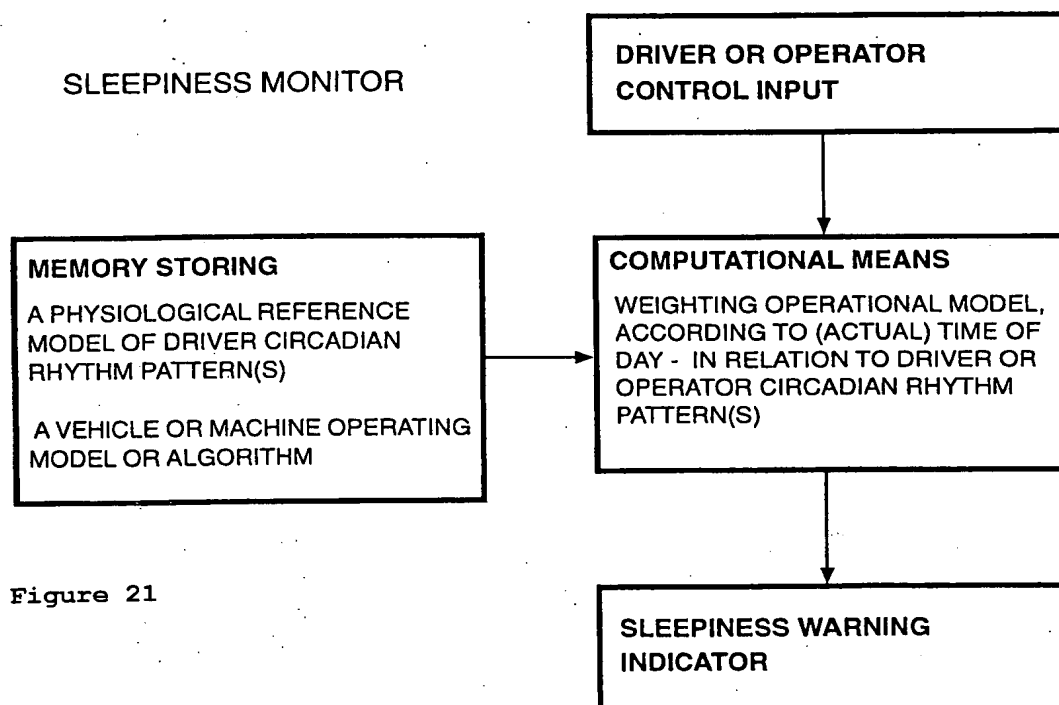


Figure 21

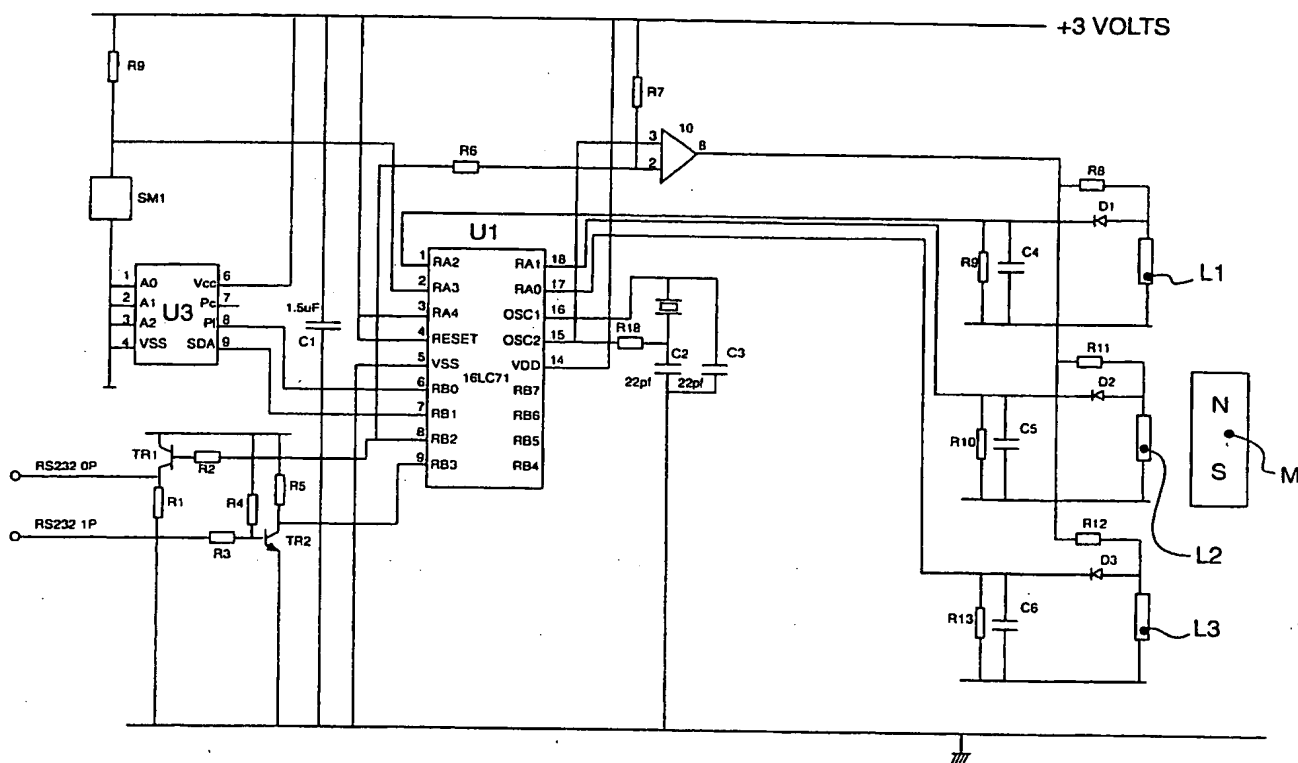


Figure 20

Table 1.

Acc # 1-Vehicle Motion
 Acc # 2-Wheel Angle
 Light Sensor - Ambient
 Temp Sensor - Ambient
 Sounder
 Mark Button

Table 2

W - Wheel Rotation Angle
 X - Measured component of g in sensor axis (m/s/s)
 K wheel - Sensor scaling factor (mm/s/s/bit)
 g - Gravity 9.81 m/s/s
 g - Gravity Vector Component in wheel Plane

$$\sin W = X / g$$

$$X = k \text{ wheel} / 1000 \times (\text{Ch}(1) - \text{ZeroWheel}) \times 1/\cos(\text{Alpha})$$

$$\sin W = k \text{ wheel} / (1000 \times g) \times (\text{Ch}(1) - \text{ZeroWheel}) \times 1/\cos(\text{Alpha})$$

$$W + \text{ArcSin} [K\text{wheel} / (1000 \times g) \times (\text{Ch}(1) - \text{ZeroWheel}) \times 1/\cos(\text{Alpha})]$$

Table 3

$$\text{RMS Steering Angle- R(Deg)} = \sqrt{\frac{\sum \text{Wheel}[n]^2}{n}}$$

Table 4

Bound Check

W Limit- < W < W Limit+
 W < W Limit-
 W > W Limit+

Steering Mode=Corrective
 Steering Mode=Active
 Steering Mode=Active

Table 5

$$\text{RMS Vehicle Acceleration-G(m/s/s)} = \sqrt{\frac{\sum \text{Acc}[n]^2}{n}}$$

Table 6

<p>T cycle = 60s T monitor = 50s T process = 10s</p>	<p>Calculate Parameters Test & Issue Warnings Update Screen Display Store Sensor Data > Disk Store Calculated Parameters > Disk</p>
--	---

Table 7

<p>Note: Data storage @ 1Hz ZeroAcc=Average {RawAcc[n]} ZeroWheel=Average {RawWheel[n]} Ch(N)=Raw ADC Value (bit)</p>

Table 8

<p>Acc[n] = Kacc/1000 x (RawAcc[n]-ZeroAcc)x1/Cos(Alpha)</p> <p>(m/s/s) (mm/s/s/bit) (bit) (bit)</p>
<p>Wheel[n] = ArcSin [Kwheel/(1000x9.81) x (RawWheel[n]-ZeroWheel)x1/Cos(Alpha)]</p> <p>(Deg) (mm/s/s/bit) (bit) (bit)</p>
<p>I = Klight/1000 x (Ch(2)-ZeroLight)</p> <p>(KLx) (Lx/bit) (bit) (bit)</p>
<p>T = Ktemp/1000 x (Ch(3) - ZeroTemp)</p> <p>(DegC) (mDegC/bit) (bit) (bit)</p>

Table 9

Engineering Scaling Factors	
K acc (mm/s/s/bit)	Acceleration Channel
K wheel (mm/s/s/bit)	Steering Channel
K light (Lx/bit)	Light Channel
K temp (mDegC/bit)	Temp Channel
ZeroLight (bit)	Intercept adjust - Light
ZeroTemp (bit)	Intercept adjust - Temp
Alpha (Deg)	Steering Wheel Inclination from Vertical
Hysterisis (Deg)	Hesterisis factor - Zero X analysis

Table 10

Sleep Propensity Algorithm - Definition	
$S_{mod} = S_{circ} + S_{zerox} + S_{rms} + S_{light} + S_{temp} + S_{sleep} + S_{road} + S_{trip}$	
Elemental	Bound Limit
S_{mod}	$0 < S_{mod} < 1$
S_{circ}	$0 < S_{circ} < 1$
$S_{zerox} = (F_{zerox}/100) (Z_{ref} - Z)$	$0 < S_{zerox}$
$S_{rms} = (F_{rms}/100) (R - R_{ref})$	$0 < S_{rms}$
$S_{light} = (F_{light}/100) (I_{ref} - I)$	$0 < S_{light}$
$S_{temp} = (F_{temp}/100) (T - T_{ref})$	$0 < S_{temp}$
$S_{sleep} = (F_{sleep}/100) (H_{ref} - (H \times Q))$	$0 < S_{sleep}$
$S_{road} = (F_{road}/100) (G_{ref} - G)$	$0 < S_{road}$
$S_{trip} = (F_{trip}/100) \times D$	$0 < S_{trip}$

Table 11

Algorithm Elementals, - S	
$S_{mod} (S)$	Modified Sleep Propensity Factor-Range 0...1
$S_{circ} (S)$	Current Circadian Sleep Propensity Value
$S_{zerox} (S)$	Current Corrective Steering Reversal Rate Deficit
$S_{rms} (S)$	Current RMS Corrective Steering Amplitude Surfit
$S_{light} (S)$	Current Ambient Lighting Intensity Deficit
$S_{temp} (S)$	Current Ambient Temperature Surfit
$S_{sleep} (S)$	Prior Sleep Good Hours Deficit
$S_{road} (S)$	Current Road Activity Deficit
$S_{trip} (S)$	Accumulated Trip Duration

Table 12

Algorithm Weighting Factors - F

Note : Factors are % S Unit per Parameter Unit

F zerox (%S/#/min)	Corrective Steering Reversal Rate Deficit - % Factor
F rms (%S/Deg)	RMS Corrective Steering Amplitude Surfit - % Factor
F light (%S/kLx)	Average Ambient Lighting Intensity Deficit - % Factor
F temp (%S/DegC)	Average Ambient Temperature Surfit - % Factor
F sleep (%S/Hr)	Prior to Good Hours Sleep Deficit - % Factor
F road (%S/m/s/s)	Road Activity Deficit - % Factor
F trip (%S/Hr)	Accumulated Trip Duration - % Factor

Table 13

Algorithm Reference Offsets - ref

Z ref (#/min)	Corrective Steering Reversal Rate - Ref Offset Corresponds to 'Alert ' Driving Subject Dependent
R ref (Deg)	Corrective Steering RMS Amplitude - Ref Offset Corresponds to 'Alert ' Driving Subject Dependent
I ref (kLx)	Average Ambient Lighting Intensity - Ref Offset Corresponds to moderate daylight
T ref (DegC)	Average Ambient Temperature - Ref Offset Corresponds to moderate environment
H ref (Hr)	Prior to Good Hours Sleep - Ref Offset Corresponds to optimum value
G ref (m/s/s)	Road Activity - RMS Acceleration / Deceleration - Ref Offset

Table 14

Algorithm Dynamic Variables	
Z (#/min)	Current Corrective Steering Zero X Rate
R (Deg)	Current RMS Corrective Steering Amplitude
I (kLx)	Current Ambient Lighting Intensity
T(DegC)	Current Ambient Temperature
G (m/s/s)	Current Road Activity - RMS Acceleration / Deceleration
D(Hr)	Accumulated Trip Duration
H(Hr)	Actual Hours of Prior Sleep
Q (#)	Prior Sleep Quality - Normalised Scale 0...1
Qx (#)	Prior Sleep Quality
	User Scale 1,2,3,4,5
	$Q=Qx/5$

Table 15

Steering Mode & Steering Limit -W limit	
W limit (Deg)	Decision limit - Steering mode detection +W limit >W> -W limit >>> Corrective +W limit <W< -W limit >>> Active
Steering Mode	Steering mode decision ACTIVE, CORRECTIVE

Table 16

Alarm Levels & Alarm State	
Alarm Level 1 (s)	Alarm level threshold
Alarm Level 2 (s)	Alarm level threshold
Alarm Level 3 (s)	Alarm level threshold
Alarm Holdoff (min)	Initial alarm forced hold-off time - N minutes
Alarm State	Alarm status decision CLEAR, LEVEL1, LEVEL2, LEVEL3, HOLDOFF

Table 17

User Software Functions	
Set Display Parameters	
Enter New Values and <RET> or <RET> to bypass edit option.	
Display History (min)	Graphic display history length - Last N minutes
FSD (S)	Graphic display full scale - S unit (0.. 1)

Table 18

Data Directory Structure	
[ALGO]*.ALG	Algorithm Data Files - Internal Format
[USER]*.ALG	User Data Files - Internal Format
[XALGO]*.CSV	Algorithm Data Files - CSV Format
[XUSER]*.CSV	User Data Files - CSV Format
[XDRIVE]*.CSV	Drive Mode Data Files - CSV Format
[XLEARN]*.CSV	Learn Mode Data Files - CSV Format

Table 19

File Structure - Program Internal Format

Note : These files in program internal readable format

Configuration File - SLEEPALT.CFG

Save Set Values @ Program Shut Down

Load Set Value @ Program Initialisation

K acc (mm/s/s/bit)

K wheel (mm/s/s/bit)

K light (Lx/bit)

K temp (mDegC/bit)

K batt (mV/bit)

ZeroLight (bit)

ZeroTemp (bit)

Hysteresis (Deg)

Alpha (Deg)

AlgorithmID

UserID

Circ[0] ... [23] (S)

FSD (0.. 1)

DisplayHist (min)

Table 20

Algorithm Data File [ALGO]*.ALG

F zerox (%S/#/min)

F rms (%S/Deg)

F light (%S/Klx)

F temp (%S/DegC)

F sleep (%S/Hr)

F road (%S/m/s/s)

F trip (%s/Hr)

Z ref (#/min)

R ref (Deg)

I ref (KLx)

T ref (DegC)

H ref (Hr)

G ref (m/s/s)

Alarm1 (s)

Alarm2 (s)

Alarm3 (s)

AlarmHoldoff (min)

W limit (Deg)

Table 21

User Data File [USER]*.USR

UserName

UserDoB

UserSex

Table 22

Data File Structure - Drive Mode Data File [XDRIVE]*.CSV

Note: These files in external readable format - CSV

DriveID

File Ceation Date

Start Time (Hr 0.. 23)

Start Time (min 0.. 59)

UserID

AlgorithmID

Alarm1 (s)

Alarm2 (s)

Alarm3 (s)

AlarmHoldOff (min)

W limit (Deg)

H (Hr)

Q (0.. 1)

F zerox (%S/#/min)

F rms (%S/Deg)

F light (%S/kLx)

F temp (%S/DegC)

F sleep (%S/Hr)

F road (%S/m/s/s)

F trip (%S/Hr)

Z ref (#/min)

R ref (Deg)

I ref (Kix)

T ref (DegC)

H ref (Hr)

G ref (m/s/s)

Z (#/min)

R (Deg)

I (KLx)

T (DegC)

G (m/s/s)

D (Hr)

S mod (S)

S circ (S)

S zerox (S)

S rms (S)

S temp (S)

S sleep (S)

S road (S)

S trip (S)

Minute Count (min) Repeat 1 .. N(min)

AlarmState

SteeringMode

Acceleration [1](m/s/s). Wheel[1](Deg)

DQC (Data Quality Code 0..255)

Acceleration [50]

Wheel[50]

Table 23

Data File Structure - Learn Mode Data File [XLEARN]*.CSV

Note : These files in external readable format - CSV

Data File Structure - User Data File [XUSER]*.CSV

Note : These files in external readable format - CSV

UserID

File Creation Date

UserName

UserDoB

UserSex

Table 24

Data File Structure - Algorithm Data File [XALGO]*.CSV

Note : These files in external readable format - CSV

AlgorithmID

File Creation Date

F zerox (%S/#/min)

F rms (%S/Deg)

F light (%S/kLx)

F temp (%S/DegC)

F sleep (%S/Hr)

F road (%S/m/s/s)

F trip (%S/Hr)

Z ref (#/min)

R ref (Deg)

I ref (KLx)

T ref (DegC)

H ref (Hr)

G ref (m/s/s)

Alarm1 (s)

Alarm2 (s)

Alarm3 (s)

AlarmHoldOff (min)

W limit (Deg)